Sustainability Should Be Fun. Designing Boardgames to Teach Sustainability

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Abstract
Teaching sustainability to undergrad students, particularly those in design degrees, faces barriers when it comes to relate core concepts such as the triple bottom line (environment, economy and social issues) or the environmental impacts of technological development with the product's life cycle in their design process or even their daily lives. It results in difficulties to understand and apply the knowledge due to the lack of practical learning when it comes to the topic. Game based learning has proven a good tool to raise understanding of certain topics, within a fun, flexible, and risk free environment that enables lateral and critical thinking. Boardgames are an accessible way to put into practice such concepts and improve understanding through play, experimentation, interaction, and repetition, combining theory with practice, thus they could help design educators to tackle sustainability issues with their students. The aim of this paper is to present the findings of a research project whose objective was to develop and test a board game with sustainability as main theme for use, within a framework of knowledge transfer, as learning tool in sustainable design courses at undergrad level.

Keywords: sustainability, game-based learning, knowledge transfer, boardgames, innovation

Introduction

Sustainability has become a major theme to consider in terms of education in higher degrees such as design, mainly due out the impact that such careers have in social an environmental terms (Papanek, 1972). However teaching sustainability faces certain barriers, as the knowledge transfer process faces the obstacles of relating the knowledge to the students' daily life experiences or how to apply sustainable thinking on their projects. Thus a proposal to overcome such obstacles and improve the students' grasp of sustainability is the use of boardgames. There is a considerable body of research on game based learning, as it has proven to be an useful tool in the teaching of conflict resolutions, strategic and lateral thinking and cooperation in a safe and dynamic environment that provides hands-on practice of theoretical knowledge. It is because of those advantages that boardgames can be used as an economic medium to teach basic sustainability concepts such as the Triple Bottom Line, the Tragedy of the Commons and how technology growth impacts the environment.

The aim of this paper is to report on the initial findings from testing a game designed for such purposes.

Methodology

This game comes about as result of a research project that explored the possibility of developing boardgames to teach sustainability to design students. The earlier stages of the project involved the selection of the concepts to use as theme for the board game (In this case the Triple Bottom Line, the Tragedy of the Commons and technological impact), the viability of using commercial games for such ends in order to generate guidelines for a game prototype that was designed and tested with three groups of students. For the purposes of the testing, two models of knowledge transfer and game based learning were used to evaluate the developed game and how effective it was. Three tests were carried out with design students, with surveys applied before and after each teste to measure their previous knowledge on sustainability and any potential improvement of the same. As well after game sessions of discussion between the players were hold to gather insight on how the related to the game and the knowledge purported to transfer.

The first model was the Knowledge Transfer Model (see figure 1) developed by Major y Cordey-Hayes (2000). This model describes a basic process in which the data is collected and translated through a re-contextualization, codification and application of nuggets of information. This model was chosen because it fits with one of the most common definitions of a board game: an interactive mathematical system made concrete and used to tell a story (Daviau, 2011). In this case sustainability is the 'story' and the mechanics are used to teach the relationship between the previously noted concepts.

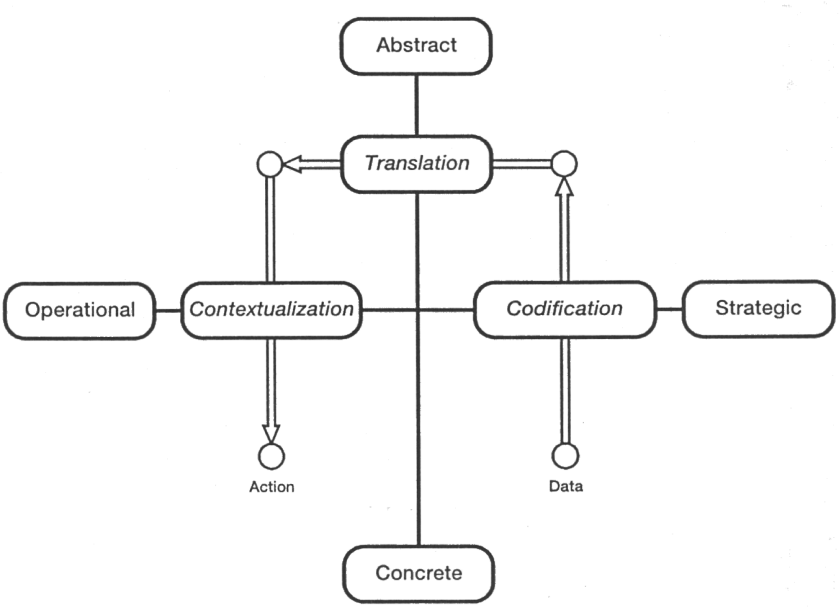

Figure 1: Knowledge Transfer Model (Major and Cordey-Hayes 2000)

The second model is the GIIL Model (Game Involvement and Informal Learning Framework) (see Figure 2) developed by Iacovides and her co-authors in 2014. Initially developed for videogames, it is considered that it can be applied to boardgames as well. It's composed of three sections, starting with the players' involvement, which can be at micro level (learning directly from the game) and at macro level (learning from activities related to the game, such as discussions, use of social networks to exchange tips, etc.) (Iacovides, et. Al., 2014). These levels have an impact on the awarness level related to a particular subject and the skills developed to understanding and applying it.

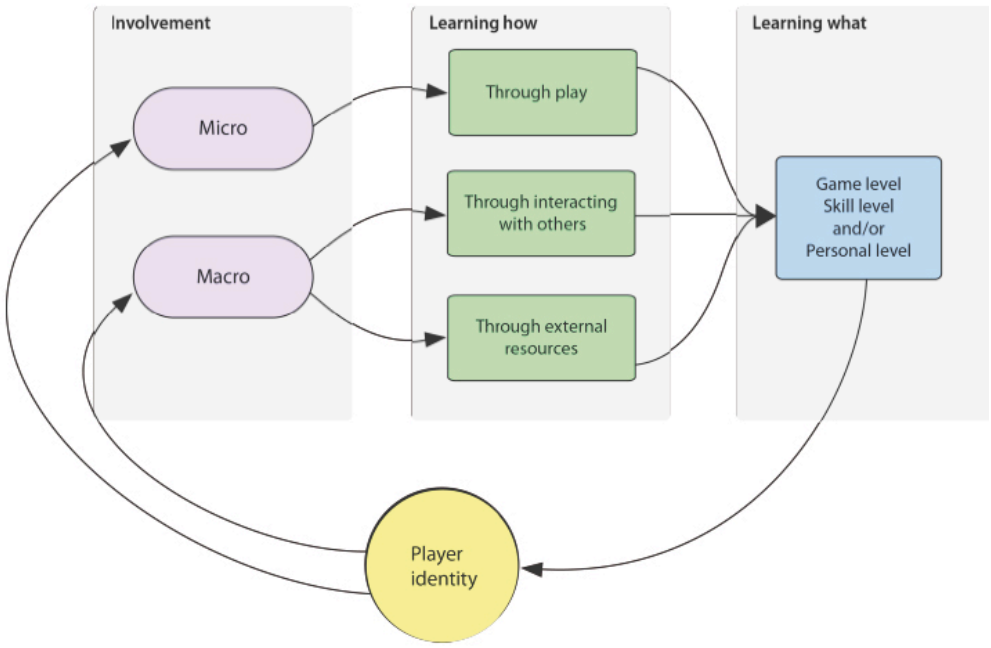

Figure 2: Gaming Involvement and Informal Learning Model (Iacovides, et. Al, 2014)

Teaching Sustainability

To teach sustainability, a multi-disciplinary approach is required, given how many diverse elements are involved. Thus it is needed to develop holistic methods to teach it (Bhamra & Lofthouse, 2004). Given that most students feel sustainability as something detached from their daily lives, they see it as an add-on to their projects (Sterling, 2001) or a mere technical problems to be solved, ignoring the social context and impacts (Humphries-Smith, 2008), rather than a philosophy from which draw guidance to develop their projects.

These approaches require the learning that develops creative solutions, iterative process and hands-on work. This is because people tend to remember 80% of what they do, compared to only the 10 to 20% of what they read or listen (Bhamra & Lofthouse, 2004).

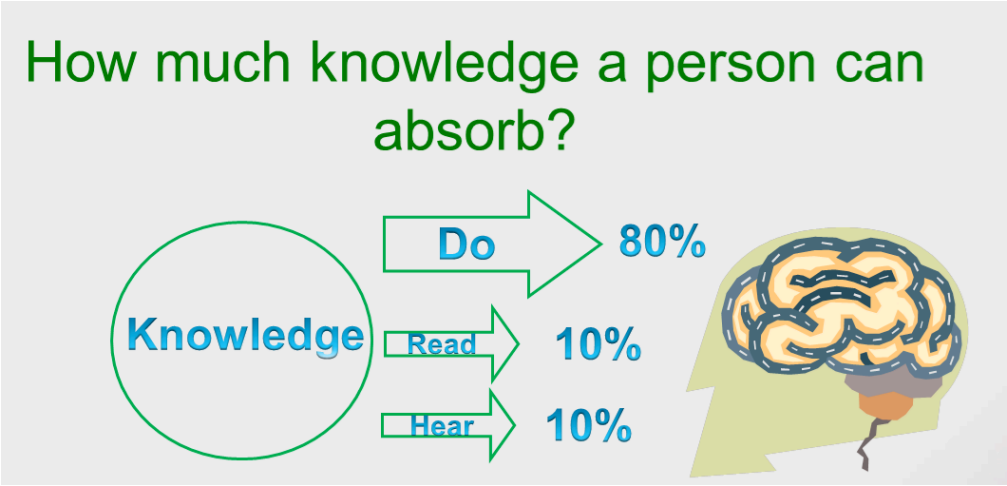

Figure 3: Meaningful Learning percentages

Thus, to generate meaningful learning, sustainable theory has to go paired with interactive exercises that allow the student to give the knowledge meaning and relevance related to their daily lives, through reflection upon those exercises (Treher, 2011). This is where learning through play enters the picture.

Learning through play

The concept of learning through play is used as a very efficient way to be used during human development, helping to the mental and physical growth of the person. As well it helps to reaffirm aspects such as personality and the ability to solve problems. Within the classroom, the use of play allows improving creativity and lateral thinking, improves communication and eases the teaching process, making it an engaging experience and enhancing the retention of information. Through games, users can undertake different roles, understanding different points of view that they would not normally experience.

Gilbert Ahamer (2006) argues that games as tool for teaching help to promote a more complete learning, with both theoretical and practice aspects obtaining a stronger link to the students' life experiences and thus the implementation of such knowledge in their projects. It can be argued that boardgames allow to explore scenarios within a

safe environment, reflect upon successes and mistakes and generate new ways of thinking, as well and enhancing the social experience of playing them (Lazzaro, 2004).

Boardgame basics and guidelines

People play boardgames for one or several of the following reasons, according to Nicole Lazzaro (2004):

1. *Hard Fun:* Players like the opportunities for challenge, strategy, and problem solving.
2. *Easy Fun:* Players enjoy intrigue and curiosity. Players become immersed in games when it absorbs their complete attention, or when it takes them on an exciting adventure.
3. *Altered States:* Players treasure the enjoyment from their internal experiences in reaction to the visceral, behavior, cognitive, and social properties.
4. *The People Factor:* Players use games as mechanisms for social experiences.

As mentioned before, boardgames can be defined as "an interactive mathematical system, made concrete, used to tell a story" (Daviau, 2011). In other words, a game is a set of rules and mechanics (depending on luck, strategy or both), designed into a set of components (boards, paper, dices, graphics) and that have a theme or themes that provide a wider framework within the minds of the users.

Game developers usually follow this sentence to describe and thus ground the basic concept of the game (Forbeck, 2011):

"[Game name] is a [category of] game in which [the players or their avatars] [do or compete for something] by [using tools the game provides them]" (Forbeck, 2011. p.p. 21)

This structure can be applied as well to this project when defining the theoretical frameworks under which work to develop games with sustainability topics.

There are three main types of boardgames, mostly derived of how game theory is understood[1], the kind of interaction required from the players (Zagal et al, 2006) and the final aim of the game in question:

•*Competitive games:* they require developing a strategy opposing the actions of the other players in order to win. They range from the simpler such as Monopoly and Risk to more complex games such as Magic the Gathering.

[1] Game theory is a branch of mathematics that studies through models the interaction between two or more actors and how their decisions have an impact in their interactions. In other words, every human interaction is a game where the decisions taken today affect the decisions that will be taken in the future and the response they will get in a feedback loop, studying how we make decisions (Stokel-Walker, 2015).

•*Cooperative games:* while allow only for a winner, they require that players have at some stage of the game objectives that are compatible or allow for trade and alliances. A good example of this kind is Settlers of Catan.

•*Collaborative games:* Often seen in horror themed games, these require that all players agree in coordinating common strategies to win, since the rival is a 'virtual' foe (or in some cases a single player opposing the rest in a different role). Either all of them win or lose (albeit some games allow for acceptable 'losses'). Examples are: Witch of Salem, Mansions of Madness and Fury of Dracula.

Figure 4: Examples of boardgames. From Left to Right: Magic the Gathering (Competitive), Settlers of Catan (Cooperative) & Witch of Salem (Collaborative).

Using commercial games as base as well as these basic concepts, a series of guidelines were developed to design the proposed game:

1. The game should allow for metagaming and improvement, in order to engage the players and thus be able to raise awareness in a practical way, of the sustainability.

2. As this is a game aimed to designers (albeit not necessarily exclusive to them), it should ask for problem solving and designing elements of the game to achieve those solutions.

3. Open the possibility of developing a game with a single winning objective but different options to achieve it.

4. Design mechanics that reflect how the decisions taken earlier in the games do have a meaningful impact on how the game develops over future turns.

5. The game should have clear, concise, easy to understand rules, in order to minimize the learning curve and increase player identity with it.

6. The game should provide enough complexity to generate metagaming, identification and high values of replay to keep the players/students engaged, but not excessively complex that they feel frustrated or disinterested in playing.

7. It is necessary to incorporate mechanics that make the player to think in terms of environment and societal development and not just economic issues and trade, in

order to punish or reward players accordingly and to enforce the idea that the winning scenario involves thinking on those three dimensions.

The developed game

The developed game, going by the name 'Vessel Planet Earth' is a cooperative game whose basis are the Triple Bottom Line, technology development impact and the Tragedy of the Commons. In it, the player represents a region with certain amount of resources that can renew or trade to use them to buy technology, with the aim of achieving space faring technology while remaining a sustainable region by balancing their triple bottom line to reach certain set value in all spheres at the same time. The first one to achieve such technology wins the game. But each purchase of technology generates a cumulative impact on Earth. When these impacts reach a milestone a natural disaster that affects all the players equally is triggered. The players can as well 'reinvest' their resources to balance their triple bottom line (investing in their environment, society and economy in other words) to make their region able to withstand a disaster. Once a certain number of disasters have occurred, the game ends for all players as a loss since this symbolizes the destruction of the planet.

Figure 6: Vessel Planet Earth

Test and results

First Test

Characteristics of the first group: it was composed by 4 players, 3 of them design students (one was a guest of elementary school age, which provided the unexpected opportunity of testing the game with younger audiences)and a facilitator to explain them the game while the researcher took notes and video.

Figure 7: First test group

Reflections & results of the first test: the players enjoyed the game as they considered that it showcased the interconnection between regions and how actions and decisions impact everyone and not only the environment of their region. They came to the realization that in a technological race, the first loser will be the environment, as people will prefer to exploit resources in their benefit rather than supporting and collaborating with others. As well they noticed that they cared only of their triple bottom line when a disaster hit them, hindering their chances to win. This first test as well helped to refine some of the mechanics of the game as well as the amount of cards available to play.

Knowledge Transfer Model evaluation of the first test: the results of knowledge transfer, analyzed with the help of the surveys and the after game session show an improvement on the awareness by the players on how delicate is the balance of the triple bottom line and how easy is to impact negatively the environment with ill thought technology projects. Also they mentioned the impact of selfish decisions compared to that of collaborating for a common goal.

GIIL Model evaluation of the first test:

•Micro level involvement: the players took their time to analyze the mechanics of the game to develop winning strategies. One of the most cited strategies was to maximize first their triple bottom line markers in order to purchase technology without care of any possible negative impact or disaster.

•Macro level involvement:

-After game discussion: the excitement from playing the game was enough to encourage a lengthy discussion on how to improve the mechanics, the knowledge learned and which decisions they would take differently to avoid destroying the planet.
-External resources: this particular group of students (with the exception of the guest) where undertaking the ‘Sustainable Design’ class at the moment.

• Increase of knowledge/skills: players showed a better understanding of the Tragedy of the Commons and how their individual decisions impacted the environment, as well as how hard is to balance the triple bottom line in real life and how they need to consider the impact that their proposed design projects could have on the environment.

•Identification with the game: the level of identification and immersion with the game by the players allowed them to play without noticing the length of the session (it ran for two hours). As well they considered that the game reinforced the themes studied in their class and in the case of the Tragedy of the Commons, clarified how it worked in real life.

Second Test

Characteristics of the second group: it was composed by 4 players, design students and a facilitator to explain them the game while the researcher took notes and video.

Figure 8: Second test group

Reflections & results of the second test: it took to rounds for the players to get involved with the game and to get a grasp of the rules. In general this group was careful when acquiring technology because they were aware of the negative impact implications; this slowed the game but minimized the risk of triggering a disaster. This group started a reflection upon how certain technologies have a bigger impact on the environment than others. It was derived from the shared attitude of thinking forward and considering the impact of their choices, including working in conjunction even if that meant that they would be helping a rival to win.

Knowledge Transfer Model evaluation of the second test: the results of knowledge transfer, analyzed with the help of the surveys and the after game session show an improvement on the awareness by the players on consumption impacts the environment and related it to the topics seen in their classes. They realized how the choices they made when developing a design project could have both positive and negative impacts on the environment and society, as well as the need for forward thinking and long term planning.

GIIL Model evaluation of the second test:

•Micro level involvement: the players realized the link between technological advancement and environmental impact. They developed joint strategies of trading resources and technology purchase in exact amounts to reduce waste. As well, once the first disaster was triggered, the players shifted towards a more conservative strategy to avoid that happening again.

•Macro level involvement:

-After game discussion: the players mentioned how it would be good for the game to include other concepts such a life cycle of products. As well they noted how during the first rounds the careless management of resources and technology reflected the current way society consumes products and generates waste.
-External resources: this particular group of students had already taken the 'Sustainable Design' class of their program.

• Increase of knowledge/skills: players showed a better understanding of the following topics: the hardship of balancing the triple bottom line; the relationship between economic activities and environmental impacts and the concept of sustainability, given that they had on their own words 'a more realistic' practice of what sustainability is through the boardgame.

•Identification with the game: this group felt immediately identified with the game (to the point the wanted to participate in future sessions) and mentioned how the game made clearer the concepts they barely paid attention to when they took the class.

Third Test
Characteristics of the third group: it was composed by 4 players, design students (one of them had never taken any sustainability related class, thus all the concepts on the game were brand new for her) and a facilitator to explain them the game while the researcher took notes and video.

Figure 9: Third test group

Reflections & results of the third test: this group showed bigger involvement with the game, including making jokes between rounds. They grasped the rules of the game faster than the other groups, playing without the help of the facilitator. They realized

that human activities such as heavy meat and milk consumption had a considerable impact on the environment. In this group the players were acting in a more altruistic way, trying to minimize the environmental impact. This took place after a player declared to feel guilty about triggering a disaster during the earlier rounds, with all the negative consequences that implied (after previously having a nihilistic point of view about 'purging the planet'). However they barely cared about balancing the triple bottom line unless they had no more choices during their turns.

Knowledge Transfer Model evaluation of the third test: the results of knowledge transfer, analyzed with the help of the surveys and the after game session show that this particular group gained an increased comprehension of the topics seen in class. In the case of the student that hadn't take the class yet, she mentioned to have now a clearer idea of what sustainability is and how technology affects not only the environment but people's lives, thus the need to be more careful on what to design and how.

GIIL Model evaluation of the third test: Micro level involvement: this particular group showed more interaction in earlier rounds, generating collaboration strategies about resources trade and management, increasing the speed of the game and reducing conflicts.

•Macro level involvement:

-After game discussion: the players of this group created jokes and talked about their realizations on how consumption generated environmental impacts, altering their shared strategy towards a collective benefit in order to avoid triggering a natural disaster.
-External resources: this particular group of students, sans one had already taken the 'Sustainable Design' class of their program.

•Increase of knowledge/skills: players showed a better understanding of the following topics: what's an environmental impact and how it results from human economic or technological activities; how easy is to forget about the triple bottom line when working on a design project and how cooperation brings more benefits to everybody on the long term.

•Identification with the game: this group considered the game so fun that felt disappointed when the test had to end. In the case of the student that had no taken any class on sustainability, the game helped her to understand better the basic concepts that she had heard from her classmates. This group suggested adding to the game a 'Curious Data' sheet to explain real life facts regarding environmental impacts. Finally, they realized that natural disasters impact everyone, regardless of their location.

Reflections and conclusions

When the project started, it parted from the following hypothesis: *if a boardgame with sustainability as core theme is developed as tool for meaningful learning, it would be possible to enhance the understanding of sustainability basic concepts.*

Based in the results obtained from these three tests, including the surveys, it seems that it is not only possible to develop such game, but shows promising signs of helping the students to get a better understanding of sustainability. However it is recognized the need to do a more continuous study on the application of this tool. It has to be noted that games can only be used so far to convey knowledge based on how long they can be played during a regular session. More complex situations might require more complex games with all the challenges they imply. There is also the need to define more concepts that can be translated to new games, such as Life Cycle Assessments or sustainable urban planning.

Games like 'Vessel Planet Earth' can help as tools for meaningful learning in a safe environment that allows for trial and mistake, practical experiences to go in conjunction with regular lessons. Games are proving to be a useful tool to overcome most common barriers when teaching sustainability in a more engaging and meaningful way.

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